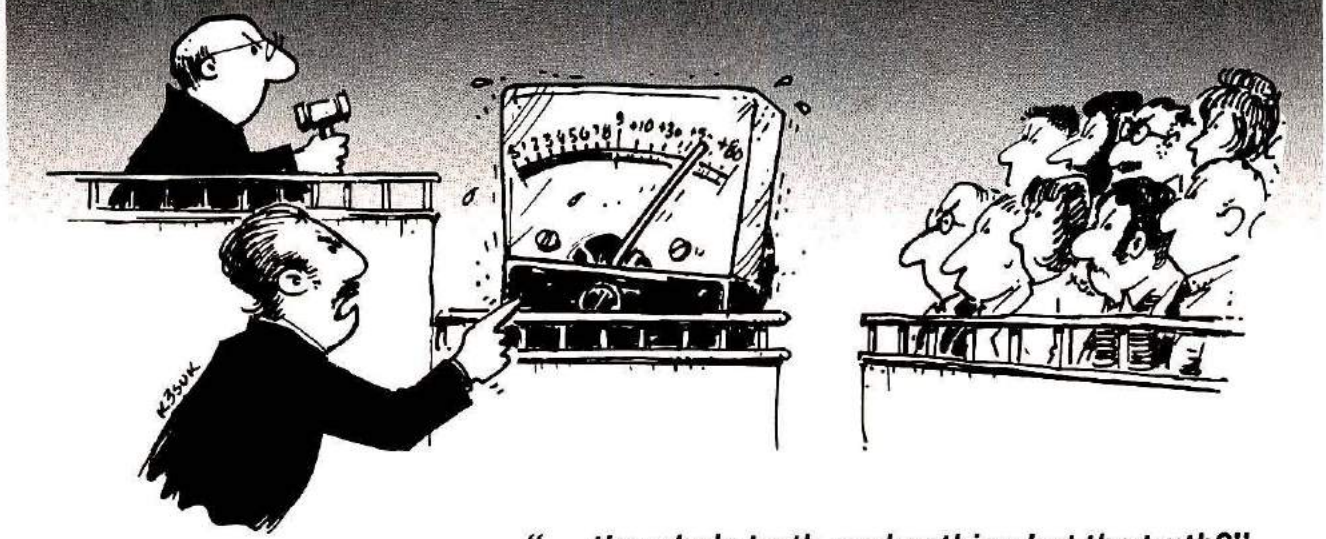
S-METERS AND SIGNAL REPORTS



"... the whole truth, and nothing but the truth?"

BY KARL T. THURBER, JR., W8FX/4

"Forty dB over S9." Not a bad signal report, indeed — certainly it's as much fun to receive as to give. But does it mean that your signal is being received some *10,000* times better (stronger) than if you had received a mere S9 report, as the math would suggest? The answer to that question is both yes and no. In this article, we'll try to see just why that is the case.

True, it's a matter of pride to see how many "dB over S9" we can push up the other fellow's S-meter with our signal. But, as we shall see, there's a bit of flim-flam associated with S-meter readings — and the readings themselves really can't be taken at face value. They must be interpreted, and a little judgment must be applied to both the receiving and giving of signal-strength reports. In this article we'll take a look, first, at the RST (readability/signal-strength/tone) system of reporting, then we'll talk about how S-meters work and touch lightly on the mathematics of the decibel. We'll also point out some S-meter calibration pitfalls and suggest how to realistically use your own S-meter. Finally, we'll ask if there may be a better way of signal-strength reporting.

The RST system of signal reporting

Over 40 years ago the RST signal reporting system came into general use by amateurs who realized the value and importance of being able to determine how well their signals were being received on the other end of a contact — and, of course, every ham still wants to know how well reception is on the other end. The RST system, from the beginning, was recognized as being relative but at the same time objective. After all, if you didn't give and receive useful reports, what was the sense of exchanging them? See **Table 1**.

The first element in the code is that of readability. It ranges from a 1 for *unreadable* to a 5 for *perfectly readable*, with three intermediate, in-between shadings possible. This part of the system gives us few problems.

The second element in the code is signal strength — this gives us the most trouble. S1 indicates a barely perceptible signal and is supposed to represent the weakest signal that could be detected on receivers of the period when the system was developed. From S1, numbers increase to S9, which indicates an extremely strong signal. The scale was set up so that the difference between consecutive S units or numbers represented the minimum change in apparent volume that the average person could detect by ear; this works out to be roughly a four-to-one change in power level. Since there are 8 S units or intervals between S1 and S9, the total change is about 50 dB, a very considerable signal range. (Until about 30 years ago, most

S-meters registered to S9 and no higher. Later on, however, it became fashionable to allow for even stronger signals to be indicated on the meter without running out of S units — driving offscale or pinning meter readings on the right.)

From this you can see that if the S-meter is really calibrated along these lines, each S unit represents an approximate 6 dB change in received signal strength (that is a change by a factor of four). To increase the strength of your received signal on the other end of your QSO by 6 dB requires increasing your transmitter power four times, other factors being equal. Or, if the other fellow should be so unkind as to give your QRP rig an S1 report (he obviously doesn't want a QSL card from you), you'd have to increase your power by *100,000* times, or go from about one watt to 100 kW, to reach S9 on his meter, to use but one example!

The last part of the RST code refers to signal tone, which is used to indicate CW signal quality. This was a very important indicator in the days when power supplies were barely filtered and keying techniques weren't nearly as sophisticated as they are today. The scale runs from **1** to **9**, a **1** indicating an "extremely rough hissing note," a **9** standing for a "purest dc note." It later became a courtesy to add letter suffixes to the report: if the signal had the steadiness of crystal control (no drift), the letter **X** was added to the report. But if the signal had a chirp, the letter **C** was added. And if key clicks were heard, **K** was added.

The "tone" part of the RST system doesn't present much of a problem, although it is actually the most subjective part. However, many hams have trouble reconciling what they should give a station for the tone element with what they actually give. Many chirpy, clicky signals are heard, which often receive ritual RST 599 reports.

The RST system is used in phone operation as well, but the tone part is, of course, eliminated. In working through fm repeaters, however, the RST code isn't too useful because what you're really reporting is how well you're receiving the repeater. More helpful to the other fellow is a plain-English description of his signal through the repeater or how noise-free his signal is (what degree of receiving quieting it possesses), especially when working direct or simplex.

As we've seen, the **R** and **T** portions of the system don't cause too much concern, but the **S** part is a good deal more troublesome — yet it's supposed to be the most objective and "scientific" part of the whole thing. For an answer to this apparent contradiction, we must understand how S-meters work and also know a little more about the decibel.

Table 1. The RST system of signal reporting. Many short wave listeners prefer the more comprehensive **SINPO** code for signal reporting, as described in the text. Whichever system you use, be honest in your signal evaluations. Use the definitions in the table as a guide for reporting realistic signal information.

readability

1 Unreadable
2 Barely readable
3 Readable with considerable difficulty
4 Readable with practically no difficulty
5 Perfectly readable

signal strength

1 Faint signals, barely perceptible
2 Very weak signals
3 Weak signals
4 Fair signals
5 Fairly good signals
6 Good signals
7 Strong signals (moderately so)
8 Strong signals
9 Extremely strong signals

tone (CW only)

1 Rough hissing note; very rough ac tone
2 Very rough ac note; harsh and broad
3 Rough ac note; appears rectified but not filtered
4 Rough note; some trace of filtering
5 Filtered and rectified ac but with strong ripple modulation
6 Filtered tone but with trace of ripple modulation
7 Near pure note, some trace of ripple modulation
8 Near perfect tone, slight trace of modulation
9 Perfect dc note, no trace of ripple modulation

How S-meters work

Many kinds of S-meter circuits prevail, but most of them work indirectly from the agc (automatic gain control) or avc (automatic volume control) bias voltage developed in the receiver. As the agc or avc voltage increases, the meter swings up-scale. Most S-meter circuits detect changes in the current of the i-f amplifier stages as the signal level rises or falls. Either way, some of the i-f signal is tapped off, amplified, rectified, and produces a dc current or voltage for the S-meter.

The meter can't be connected directly across the agc or avc line because the meter would appear as a short circuit. Instead, amplification is provided through a separate agc/avc amplifier stage. (Some inexpensive tube-type receivers have this amplification in a stage already serving as an rf or i-f amplifier. This is economical but can interfere with the normal operation of the stage.)

You may wonder why some S-meters appear to be built backward, so that the needle rests on the right side of the scale (rather than on the left) and moves to the left as current increases, or even appear to be mounted upside down with the meter scale inverted so that it reads "right-side up." This is because

Manufacturers use a wide variety of calibration standards and dynamic ranges for their S-meters. This transceiver S-meter is calibrated from S1 to S9 plus 40 dB.

(especially in older tube-type equipment), the avc line feeding the S-meter produces a larger negative voltage on strong signals, reducing the current flow through the S-meter amplifier. Without special construction, many S-meters would read backward, with strong signals indicated on the left side of the face and weak signals on the right. Most S-meters are fairly heavily damped so that they don't swing too widely on small variations in signal strength caused by rapid flutter or fading.

An *ideal* S-meter would be calibrated in microvolts rather than in S units, since the latter is only a very indirect indication of signal strength at the receiver antenna terminals (which is what we're really interested in). Such an ideal meter would read near zero on background noise, and readings would be constant when switching between bands. Readings wouldn't be affected by impedance mismatch at the antenna terminals, by different i-f gain-control settings, by tube and component aging, or other factors that make accurate and consistent readings hard to come by. Such a meter would really be a precision field-strength meter — an instrument we're not likely to see in any reasonably priced Amateur or SWL communications receiver.

Before discussing the problems of S-meter calibration and suggestions as to how to best use your S-meter, it's useful to get ourselves firmly grounded in just what constitutes an S unit. Let's look now at the basic unit of signal change, the *decibel* (dB).

Decibels and S-meters

The decibel isn't at all forbidding once you understand a few basic facts about the subject. A little knowledge about decibels will also help you interpret antenna, microphone, and receiver-gain advertising claims.

Understanding the decibel: the decibel, which is 1/10 of a *bel* (named for Alexander Graham Bell), is simply the *logarithm of the ratio of two power levels.* It's not a real or absolute quantity at all — just a ratio of relative measurement. The decibel is supposed to represent the change in audio power level that's just detectable by ear under ideal conditions, based on the fact that the human ear has a logarithmic response to sound. Stated mathematically:

$$dB = 10 \log P2/P1 \qquad \textbf{(1)}$$

This ratio is basically a power ratio (what we're most concerned with in communications work) where the output power, $P2$, is some ratio of the input, $P1$.

The decibel can also be expressed in terms of either voltage or current. (However, note that voltage or current gain or power comparisons expressed in dB should be measured across the *same value* of impedance otherwise the ratios won't be correct — it's sort of an "apples and oranges" type of comparison if you don't have a common impedance base for measurement.)

When used to compute decibels in terms of voltage or current, **eq. 1** becomes:

$$dB = 20 \log E2/E1 \text{ or } I2/I1 \qquad \textbf{(2)}$$

where $E2/E1$ and $I2/I1$ are the voltage or current ratios respectively.

The mathematics aren't really as formidable as they appear. It's a matter of simple arithmetic, really, with the use of published logarithm tables. (Or perhaps your calculator has a key for obtaining logarithms.) For example, here's how the first entry of **Table 2** was obtained mathematically:

$$dB = 10 \log P2/P1 \text{ (for power)}$$

The ratio is 1.25, which is the ratio of 100 watts to 80 watts (for example). So,

$$dB = 10 \log 1.25$$

The logarithm of 1.25 is 0.09691. Multiply this number by 10 and you have 0.9691, which rounds off to 1.0 dB. Now, to find the dB equivalent for the same voltage or current ratio, all you do is multiply the log of 1.25 by 20 (**eq. 2**), which yields 2 — just twice that for power.

If you work out the math you'll see that a four-to-one power increase is equivalent to a 6-dB increase, or one S unit; a two-to-one increase is a 3-dB (half S unit) change; whereas a 25 per cent power increase is but a 1-dB change. The process also works in

reverse; if P1 exceeds P2, you have a negative change, or a dB loss. **Table 2** gives common dB, power, and voltage ratios.

The beauty of the decibel system is that you can add decibels (just as you can logarithms) rather than multiplying. For example, you can just add circuit gains of successive amplifier stages, or even add and subtract power amplifier gain, transmission-line loss, and beam antenna gain to arrive at composite gain figures.

Most amateurs think of the dB as a simple ratio — a relative unit, as used in the S-meter. However, you can increase dB flexibility by assigning to it a reference level as a basis for comparison or measurement. Any signal characteristic and level can be used as a reference so long as the reference is related to power. For example, in antenna measurements, gain is usually compared with a simple dipole (dBd) or an isotropic or "point-source" radiator (dBi).*

Audio or rf power levels may be stated in terms of dBm, which is becibels referenced to

S-meters are relative signal-strength indicators. But an attenuator such as this can be used to reduce the signal passing through the meter and thus can be used to make accurate comparisons of different signal levels feeding your receiver. Such a device is useful in working with antennas, checking preamplifier gain, or evaluating the real effect of a friend's linear amplifier or a beam antenna (*Photo courtesy B&W.*)

a level of 1 milliwatt through a known resistance, usually 50 ohms. You may see other references, too, such as dBW (1 watt) or dBn (thermal noise). In receivers, sensitivity is often shown as being so many microvolts for a "10-dB signal-to-noise plus noise" ratio, and so on — the possibilities are endless.

Guidelines for using decibels

From this discussion of decibels there are some rules of thumb to remember that will come in handy when evaluating signal reports, buying antennas, or deciding whether to invest in a new rf amplifier.

The first is that, whenever you double the power ratio, you add 3 dB on the decibel scale (6 dB if you're working with voltage).

The second thing to remember is that each 10 dB represents a power-of-ten change in the power ratio (20 dB for voltage). You can also state this rule another way: for each zero in the power ratio, add 10 dB. Thus, a ratio of 1000-to-1 in power is equal to 30 dB (three zeros in the number).

Related to this rule-of-thumb is a third thing to remember when working with decibels: adding decibels is just like multiplying power ratios.

A fourth point to remember is that the rules of thumb we've mentioned for power ratios also hold for voltage ratios — that is, the voltage ratio in dB is just twice what the rules for power ratios would have it. Still unclear? A look at **Table 2** will show how these rules-of-thumb are related. See if you can verify the tables yourself!

Decibels and the S-meter: this discussion of decibels and a glance at **Table 2** should make it plain that if S-meters were perfectly calibrated and could therefore be taken at face value, there's a really whopping change between an extremely weak S1 signal and a needle-pinning signal of 60 dB over S9. Next time you're pleased to receive an exceptionally complimentary signal report, you might want to try reducing

Table 2. Handy decibel chart showing relationships between dB ratios in terms of power and voltage. (For convenience the values have been rounded off, and some values have been deleted when odd ratios occur.) The chart can be used to obtain dB changes instead of working out the mathematics in the text.

dB power	ratio	dB voltage	dB power	ratio	dB voltage
1	1.25	2	21	125	42
2	1.56	4	22	156	44
3	2.0	6	24	250	48
4	2.5	8	25	312	50
5	3.125	10	27	500	54
6	4.0	12	28	625	56
7	5.0	14	30	1000	60
8	6.25	16	31	1250	62
9	8.0	18	33	2000	66
10	10.0	20	34	2500	68
11	12.5	22	35	3125	70
12	16	24	36	4000	72
13	20	26	37	5000	74
14	25	28	38	6250	76
15	32	30	39	8000	78
16	40	32	40	10,000	80
17	50	34	41	12,500	82
18	63	36	44	25,000	88
19	80	38	47	50,000	94
20	100	40	50	100,000	100

*We're a bit afield of our S-meter discussion, but no mention of decibels is complete without cautioning you to read antenna gain figures very carefully. Antenna gain can be referenced against either the dipole or the isotropic source. A dipole is a better antenna than an isotropic radiator, having a theoretical gain of 2.1 dB over the latter. Thus you may possibly see an ad for a "wonder dipole" that advertises a "2.1 dB gain." Beware!

power from, say, 1000 watts to 250 watts, or from 100 watts to 1 watt to see where you now fall on the other fellow's S-meter. The odds are that (assuming stable band conditions) you won't drop as much on his meter as you might expect; or at least you won't drop exactly in proportion to the drop you might expect from a look at the dB chart of **Table 2**.

Reducing power: How much should your signal change on the other fellow's S-meter if you reduce power? Assume that he has given you an S9 signal report and you're running 500 watts output. In that case — given no fading and an accurate S-meter with 6-dB S-unit intervals; if you cut your power to 125 watts, your signal should now read S8; reducing to 31 watts, S7; 8 watts, S6; 2 watts, S5.

If he's still copying you, reducing power to 0.5 watt, you should read S4 and so on. If the band isn't too noisy or plagued with interference, he may still hear you at these QRP levels, since S1 represents a signal level of about 0.4-0.5 microvolts. This point lies just on the threshold of hearing of most modern receivers and transceivers.

Armed with this knowledge of decibels, you might want to construct a simple experiment on your own S-meter, not only as a check on it, but to get a feel for what really happens to signal strength on the other end of a contact when a linear amplifier or beam antenna is used.

Often you'll hear reports indicating that when a linear is kicked in, the signal improves 20-30 dB on the other end. Normally, such a dramatic increase in signal strength just isn't real, since you'd have to increase power from 10 to 1000 watts for a 20-dB increase. (Typically, if you go from 100 watts "barefoot" to a full kW, your signal should increase more like 10 dB, remembering our "power-of-ten" rule, or going to **Table 2**.

That matter of calibration

S-meters vary widely in their calibration accuracy. This isn't surprising when you consider the fact that, first, the meter only indirectly represents some quantity (received signal strength at the antenna terminals, as measured in microvolts); and second, many variables in different receivers (and even identical receivers of the same type) affect S-meter readings as well. Let's now turn to some of the problems of calibration.

Hams have been complaining since the first S-meter was tacked onto a receiver that his meter was either "scotch" or "Santa." Some meters could barely be coaxed up to S9 on the strongest of signals, while others read S8 on background noise. Normally, S-meter calibrations are set so that the noise runs about an S1 to S3 and an extremely strong, noise-free signal registers S9 or higher . The average signal reads S6-S7 with just a trace of noticeable background noise.

Manufacturers' standards: Probably the most important reason why S-meter readings are hard to compare with each other is that the different receiver and transceiver manufacturers don't all use the same standard. Each has his own method of calibration as well, and component variations in receivers of the same model and make may cause the S-meters to act differently.

Around World War II some attempt at standardization was made, with most (but not all) manufacturers agreeing that a signal of 50 microvolts at the antenna terminals would represent an extremely strong, or S9, signal on the meter. Most meters were physically designed so that this occurred at about midscale. The divisions below S9 were marked in 6-dB units down to S1, and increments above S9 were ticked off in 10 dB chunks of up to 40 or 50 dB (or more).

Looking at some of the more popular manufacturers' products, National, Drake, Hallicrafters, and Hammarlund receivers all register S9 with a 50-microvolt signal input. However, Swan and Collins equipment requires a 100-microvolt signal for an S9 reading. All have 6-dB S units, except for Drake, whose scale is divided into 5-dB S units. (See **Table 3**.)

Most of these "standards" assume a 50-ohm receiver input impedance with readings accurate only on a stated

This Yaesu hf transceiver S-meter is calibrated to S9 plus 60 dB and therefore represents a total dynamic range of about 110 dB. Thus, the strongest signal that can be registered on the meter will be millions of times stronger than the weakest detectable signal. Actual S-meter readings will vary from band-to-band and from receiver-to-receiver or transceiver. (*Photo courtesy Yaesu Electronics.*)

frequency band. (Many imported radios use different standards, and some don't seem to use any at all — or they're not saying so in the instruction manual!)

S-meters, old and new: after World War II, when S-meters became fairly common on ham receivers, most went only to S9, which was considered to be an extremely strong signal; stronger signals just pinned the needle on the right. The recent trend has been to higher and higher calibrations, up to 80 dB or more above S9. A glance at **Table 2** shows how unrealistic the very high dB scales probably are. For example, a 100-microvolt signal (S9 on many meters) would rise to a full 1 volt at the antenna terminals at 80 dB over S9. This is a voltage ratio of 1:10,000. Over long signal paths, only super-power transmitters, very high-gain antennas, and good propagation conditions can really produce signal levels such as these! (See **Figs. 1** and **2.**)

S-meter variations: besides the differences between manufacturers as to how their S-meters should read, many other complications make S-meter readings suspect at best.

Table 3. Comparative S-meter calibration standards used by various American receiver manufacturers in terms of microvolts required at the receiver antenna terminals to produce an S9 reading. Some overseas manufacturers use different standards, and some don't say what standards they're using.

manufacturer	microvolts at antenna terminal for S9 reading
Hammarlund	50
National	50
Hallicrafters	50
Swan	100
Collins	100
Drake	50

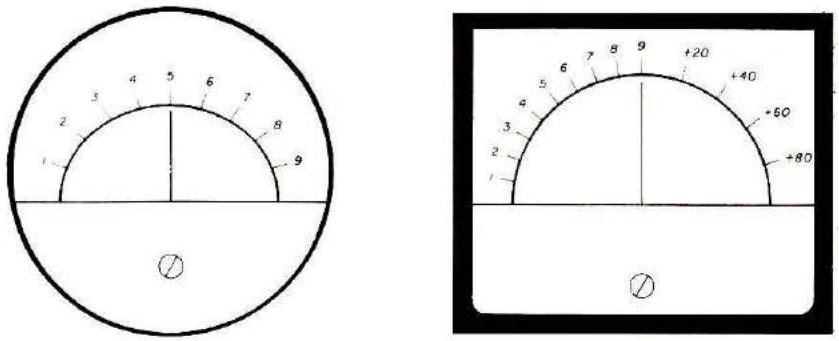


Fig. 1. When S-meters first became popular the scale usually went to only S9, which represented an extremely strong signal. On today's meters, S9 is usually at midscale and readings progress to 40, 60, or even 80 dB above S9. Are such readings realistic?

For example, most receivers and transceivers have an S-meter adjustment control, which is used to zero set the S-meter with no signal input and with the rf-gain control at minimum. The meter can get out of adjustment. Also the setting of most receivers' rf gain or attenuator controls affects S-meter readings. In most cases, the controls must be set all the way open for the meter to read as it should. Change the settings and you change your S-meter calibration.

Variations in the tubes or transistors in the S-meter amplifier circuit, as well as components in the rf and i-f amplifiers, can and do affect meter accuracy. As components age meter readings are affected, although overall receiver performance may not be noticeably affected. Variations in receiver gain between bands can also cause wide differences in S-meter readings from band-to-band. Usually, the lower bands favor more generous S-meter indications. (Ham-band-only equipment is a little better than general-coverage gear in this respect.)

Even variations in the receiver local-oscillator injection level from band to band may cause S-meter readings to be inconsistent. And, of course, the manufacturer's S-meter calibration standard assumes a given receiver input impedance; if this changes, readings will not be uniform or accurate.

One other important factor in S-meter variations is that the characteristics of the avc or agc circuit affect readings. Different avc circuits have different time constants or response times. Component values can change, which in turn affects the overall avc or agc voltage levels from which the S-meter derives its input. Also, when tuning a weak signal close to a very strong one (especially with the rf gain wide open), the stronger signal is likely to take control of the agc circuit and cause the S-meter to respond to it rather than to the signal you're actually trying to copy. This effect is especially pronounced in receivers with insufficient i-f skirt selectivity to reject strong adjacent signals.

When receiving CW and ssb, another problem arises. The S-meter may not be able to follow the CW keying or ssb voice modulation fast enough; it tends to bounce like a rubber ball trying to keep up with signal peaks (some receivers have selectable agc time-constant speeds, which help to minimize, though not eliminate, this problem.)

Using rf and af gain controls: While it's usually necessary for the meter's electrical and mechanical zeroing controls to be accurately set, and for the rf gain control to be run wide open for reliable readings, bear

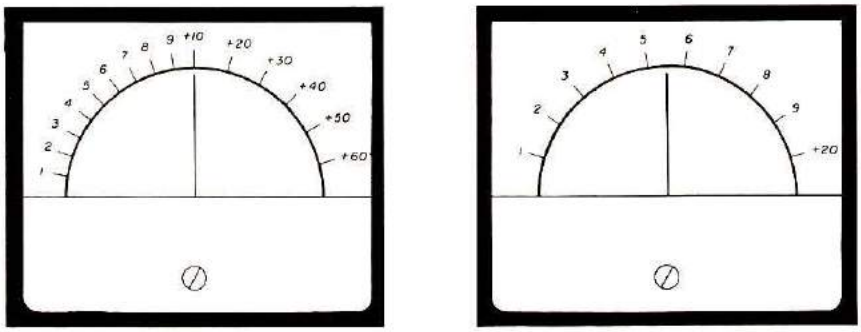


Fig. 2. S-meter scales are suspect just from an examination of their physical appearance. The scale at left is designed to produce very inflated readings compared with the more modest scale of the meter at right. As indicated in the text, neither should be taken at face value.

in mind that the purpose of the rf gain control is not to fine-tune the S-meter. Instead it should be used to help ensure that the proper signal level is presented to the receiver i-f strip and detector. There's usually an optimum setting or balance for your rig's rf and af (audio frequency) gain controls that will minimize signal distortion yet provide adequate sensitivity without overloading. Try running with the audio gain control advanced about halfway (especially for CW and ssb reception). Then adjust the rf gain control for clearest reception, forgetting for the moment about the S-meter. This procedure usually produces the best signal-to-noise ratio with minimum distortion.

How to calibrate your S-meter: to custom-calibrate your S-meter for more accurate signal reporting, you can use a signal generator with a calibrated attenuator and known output level to calibrate your S-meter in terms of microvolts. You can establish a 50-microvolt reading at midscale (S9), with weaker signals spread out on the lower end of the scale, and stronger signals on the right, above S9.

Using the signal generator, you can tick off markers at every 6-dB point to indicate S1 through S9; markers can be established at any convenient interval above S9, say at every 10-dB point. Another even simpler way to calibrate is to run the generator output into your receiver and note the signal level that just *barely* moves the meter; call this point S1. Advance the signal generator in 5- or 6-dB steps, marking the S-meter with another S-unit at each step until S9 is reached. Mark off 10-dB steps thereafter.

Most of us don't have access to such elaborate rf test equipment, and going through such tedious calibration procedures probably isn't worth the trouble. But you might try something like the following procedure, which should serve well enough for most purposes:

1. Disconnect your antenna and short circuit the antenna terminals.

2. Tune the receiver or transceiver to a given band.

3. Mechanically and electrically zero the S-meter according to instruction-manual procedures.

4. Reconnect the antenna and remove the short from the antenna terminals.

5. Adjust the S-meter sensitivity control (if there is one) until the receiver S-meter reads full scale on the very strongest signal you can find, as from your own transmitter or a very strong local station.

6. Adjust the receiver rf gain control or attenuator control until the receiver S-meter reads between S1 and S3 on background noise. Note this setting.

7. Use the rf gain control or attenuator to adjust incoming signals, then return it to the setting marked in step **6** when you want to make a calibrated S-meter reading.

You may have to modify this procedure to coincide with your own equipment calibration procedures contained in the instruction manual. You may also find that you'll have to repeat the procedure when changing bands in order to get consistent readings.

Realism: is there a better way?

After saying all this, just what can your S-meter reasonably be used for? We've shown that it's difficult to calibrate the S-meter accurately, and it can't be relied on for true measurements of signal strength. However, there are some practical and prudent uses for your S-meter:

A. As a *relative signal strength indicator*, to help you compare apparent differences in signal strength of signals on a given band at a given time.

B. As a *tuning meter* to help you tune in an incoming signal and center it in your receiver's i-f passband. You can't place a signal right on the nose using your S-meter alone, but you can at least get into the ballpark by using the meter as a convenient tuning aid. (However, be aware that in fm work, a zero-center deviation meter is more useful in accurately positioning received signals in the i-f passband.)

C. As a relative *field strength meter.* This is useful in working with a nearby ham in helping him adjust or tune his antenna system. Received signal-strength indications on your meter will follow the results of his adjustments (such as tuning, positioning, cutting beam elements, and making comparisons between two or more antennas).

Note that while your S-meter can't be used to make absolute

readings, if you use it with a calibrated rf attenuator as shown in **Fig. 3**, you can obtain fairly accurate measurements of dB changes in received signal levels; this would be helpful, for example, in checking the front-to-back ratio of a friend's beam antenna.

Reliable results depend on a stable transmission path with no fading, so it's practical to make such checks and comparisons only with a local ham — if you try it on DX, you can't be sure of the results.

To use the attenuator, try the following procedure:

1. Set the attenuator for zero or no attenuation.

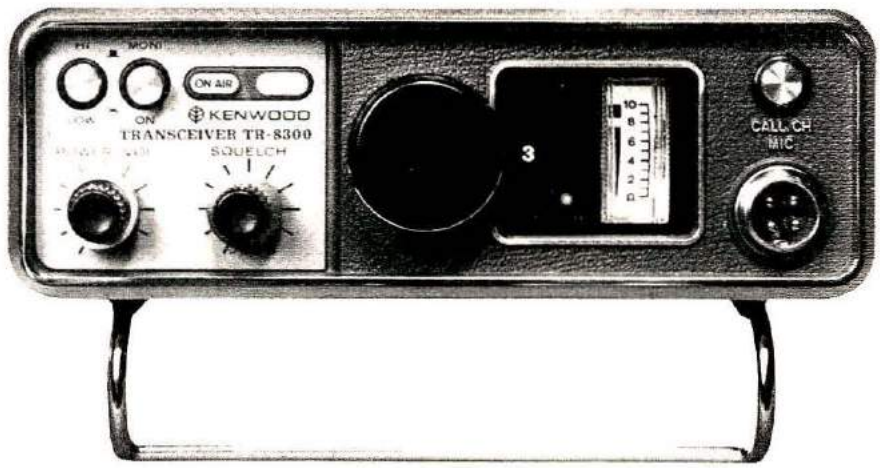
2. Observe and note the two signal levels on the receiver S-meter.

3. Adjust the attenuator to cause the same change in signal level as previously noted on the meter.

4. The amount of attenuation needed to cause an identical change in S-meter reading is the actual number of decibels the signal varied, regardless of any S-meter inaccuracies.

This technique should be useful in conducting antenna experiments and for measuring the true gain of preamplifiers used with your transceiver or receiver. Barker and Williamson make an inexpensive attenuator, or you can build your own from designs in the *Radio Amateur's Handbook*.

Note: If you use such an attenuator with your transceiver, be sure to switch it out of the line or disconnect it before applying rf (transmitting). Step attenuators of this kind are designed for very low power levels!



There really isn't a great need for an S-meter when operating through repeaters. But it's a handy device to use as a tuning meter during transmitter hunts and for simplex work. All S-meter calibrations are relative despite what the instruction manual may say. This Kenwood transceiver goes all the way in this respect; it doesn't even use regular S units on its scale but rather a simple 0 to 10 calibration. (*Photo courtesy Kenwood.*)

D. As a *rough beam-positioning indicator*. You can use your S-meter as a cross check on your beam directional indicator by peaking it on received signals after first roughly positioning your antenna by the compass. (See if they coincide.)

E. As a *peak or null meter for rf bridges*. These devices need some kind of indicator of bridge balance or tuning. Most receiver noise bridges (used to tune and adjust antennas of all kinds without requiring you to feed rf into the antenna) make use of your receiver S-meter to detect a noise peak or null, which in turn indicates antenna resonant frequency.

S-meter psychology

Various writers have suggested technical improvements in S-meters, such as spreading out scale units to create wider spacings with 9- or 12-dB intervals, thereby requiring much stronger signals to drive the meter to full scale. Others have suggested trying to compress the total S-meter range into a 70-dB scale, based on the fact that, on peaks, normal human speech exceeds the audibility threshold by about this much. These suggestions are good attempts at realism, but they don't solve the calibration problems we have highlighted, not to mention the psychological aspects of signal reporting.

The business of "S-meter psychology" is very real indeed, and has a considerable impact on all aspects of reporting. Even assuming a perfectly calibrated S-meter, two persons observing the very same signal on the same receiver may not agree as to the correct S reading. Many operators also add or subtract a personal fudge factor, which takes into consideration their own estimation of their equipment and antenna as well as subjective factors such as whether the other station is DX, is using flea-power (QRP) equipment, and so on. And, sadly, many operators (particularly in contests) can't be bothered to separate the men from the boys in doling out reports, giving 579 CW and 59 phone reports as a matter of ritual, regardless of signal strength and quality.

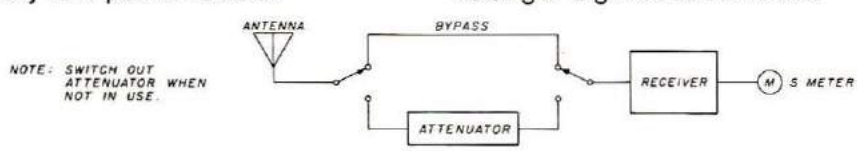


Fig. 3. Measuring signal-level changes with a step attenuator. Signal levels are relative. However, we can still make a fairly accurate comparison of signal-level changes between two signals of interest by inserting a step attenuator in the coax cable to the receiver. It's important that the attenuator be switched out when not in use if your rig is a transceiver (see text).

While we've talked here mostly about S-meters themselves, it may just be that our whole system of RST reporting needs revamping. It may be that the full 9-unit-plus S-meter scale may be a bit misleading and perhaps even ridiculous. Back in the thirties, the simple QSA scale (S1 to S5, from weakest to strongest signal) had a lot going for it, because the five possible reports were really all you could say about a signal.

The present RST system has been used for over 40 years and has served its purpose well. But it doesn't tell the fellow at the other end anything about propagation conditions, interference noise level (which may itself be S9), or overall signal merit. Serious swls (short-wave listeners) have for years used a system known as SINPO for signal reporting, and it may be well to consider this system for amateur use. If you're not familiar with the code, the letters stand for **S**trength, **I**nterference, **N**oise, **P**ropagation, and **O**verall average; following each element or letter is a number from one to five. The code looks something like this:

S	I	N	P	O
(signal strength)	(interference)	(noise)	(propagation)*	(overall merit)
5 excellent	5 nil	5 nil	5 nil	5 excellent
4 good	4 slight	4 slight	4 slight	4 good
3 fair	3 moderate	3 moderate	3 moderate	3 fair
2 poor	2 severe	2 severe	2 severe	2 poor
1 barely audible	1 extreme	1 extreme	1 extreme	1 unusable

*degree of disturbance

Using this system, a super signal in all respects would receive a maximum **SINPO** rating of 55555. But if the signal were weak, bothered by QRM (interference) and QRN (noise) together with bad band conditions, it might receive a report of 23323, the last number being mentally averaged from the first four; it can also be used to denote signal quality.

This system has the advantage that it is much more descriptive of a signal's true merit than the much simpler RST system, and it lets the other fellow know *all* the factors affecting his signal on your end. It, too, tends to eliminate the ridiculous "more is better" type of report (80 dB over 9) so often heard on the bands. But this system takes more time to calculate and transmit, so it might be of limited usefulness during a contest when brevity is required. It also throws out direct S-meter readings, which may offend operators who must know how far they can kick up the S-meter on each and every QSO.

Giving honest reports

This discussion brings us to a final word about honesty in signal reporting — not just in terms of S-meter readings, but in terms of the whole system. The reason we give signal reports is not out of ritual or the need to inflate (or sometimes deflate) the other fellow's ego, but to report on the overall merit of his signal. Why give reports at all if they have no meaning but simply fill a square in a logbook? The fellow on the other end needs an honest, thoughtful report to help him optimize adjustments on his equipment and to detect malfunctions.

When giving reports pay close attention to just what you're telling the other fellow. If he has splatter, chirps, birdies, clicks, or whatever on his signal, by all means tell him so. It helps your credibility to tell him just why you gave him an uncomplimentary report, since most of those he receives won't reveal his signal problems.

Helpful, informative, and realistic reports are necessary in today's crowded and competitive bands, not only for the other fellow's benefit, but for your own and for the benefit of Amateur Radio. Our privilege of using valuable spectrum space depends, in large measure, on keeping our act clean!

Summing up

We've tried to separate fact from myth concerning the use and interpretation of S-meters — to debunk the considerable nonsense that envelops the whole subject. We've presented the basic system of signal-strength reporting, we've seen just how S-meters work, and we've looked at a bit of math behind the decibel.

We have also shown some of the major S-meter calibration problems, and given some pointers for realistically using and interpreting your S-meter. Finally, we've made some suggestions for improved signal reporting that will be thought-provoking.

The bottom line is that the S-meter is a *relative* signal-strength indicator or tuning meter for your receiver or transceiver, but little more. It's wise to take all signal-strength reports you may receive with an air of skepticism and to be judicious in the reports you award, for S-meters are indeed vanity instruments. If you appreciate the limitations of S-meters, you know all there really is to know about them.

HRH